Quantifying cell-induced matrix deformation in three dimensions based on imaging matrix fibers.

Journal: Integr Biol (Camb)

Publication Year: 2015

Authors: Jacob Notbohm, Ayelet Lesman, David A Tirrell, Guruswami Ravichandran

PubMed link: 26021600

Funding Grants: Engineered matrices for control of lineage commitment in human pancreatic stem cells

Public Summary:
During processes such as development and cancer metastasis, cells migrate into three-dimensional fibrous matrices. Previous studies have speculated on the mechanical forces required for migration by observing matrix fiber alignment, densification, and degradation, but these forces remain difficult to quantify. Here we present a new experimental technique to simultaneously measure full-field 3D displacements and structural remodeling of a fibrous matrix, both of which result from cellular forces. We apply this "2-in-1" experimental technique to follow single cells as they invade a physiologically relevant fibrin matrix. We find that cells generate tube-like structures in the matrix by plastically deforming their surroundings, and they re-use these tubes to extend protrusions. Cells generate these tubular structures by applying both pulling and pushing forces.

Scientific Abstract:
During processes such as development and cancer metastasis, cells migrate into three-dimensional fibrous matrices. Previous studies have speculated on the mechanical forces required for migration by observing matrix fiber alignment, densification, and degradation, but these forces remain difficult to quantify. Here we present a new experimental technique to simultaneously measure full-field 3D displacements and structural remodeling of a fibrous matrix, both of which result from cellular forces. We apply this "2-in-1" experimental technique to follow single cells as they invade a physiologically relevant fibrin matrix. We find that cells generate tube-like structures in the matrix by plastically deforming their surroundings, and they re-use these tubes to extend protrusions. Cells generate these tubular structures by applying both pulling and pushing forces.